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A New Vegetative Albino Form of the Otherwise Mixotrophic Orchid *Cephalanthera subaphylla* (Orchidaceae)

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A new, achlorophyllous form of *Cephalanthera subaphylla*, f. *leucophylla* Suetsugu, is described. Because *C. subaphylla* is known to be strongly mycoheterotrophic and obtains most of its carbon from mycorrhizal fungi, the high dependency on mycobionts may have lead to the persistence of albino mutants in *C. subaphylla.*

Key words: Japan, mixotrophy, mycoheterotrophy, taxonomy

All 25,000 species of orchids are assumed to be initially mycoheterotrophic, which means they rely on a fungal host for their carbon and mineral nutrient during the early seedling phase (Cameron *et al*. 2006). Later on, however, most orchids develop green leaves and become autotrophic. Regardless, more than 200 species of orchids remain achlorophyllous throughout their life. Those orchids totally depend upon their fungal host for carbon and most likely for mineral nutrients. This nutritional mode is referred to as full mycoheterotrophic (Leake 1994).

While the vast majority of orchids develop photosynthetic leaves and are fully autotrophic in adulthood (Cameron *et al*. 2006), several orchids have a mixotrophic strategy where they obtain carbon not only through photosynthesis, but also from mycorrhizal fungi (Gebauer & Meyer 2003). Mixotrophy is often considered to be an intermediate state leading to full mycoheterotrophy, which evolves after the establishment of mixotrophy rather than through direct transition from autotrophy to mycoheterotrophy (Selosse & Roy 2009, Motomura *et al*. 2010).

Some mixotrophic orchids produce fully achlorophyllous leaf-bearing variants that can reach nearly the same size as their green counterparts (reviewed by Selosse & Roy 2009). The genus *Cephalanthera* includes both fully and partially mycoheterotrophic species, five species and four forms of which are known to occur in Japan (Hayakawa *et al*. 2014, 2016). *Cephalanthera falcata* (Thunb.) Blume f. *falcata*, f. *albescens* S. Kobay., f. *conformis* Hiros. Hayak. & J. Yokoy., *C. erecta* (Thunb.) Blume, *C. longibracteata* Blume f. *longibracteata*, f. *lurida* Hayashi, and *C. longifolia* (L.) Fritsch have well-developed foliage leaves, while *C. subaphylla* Miyabe & Kudô f. *subaphylla* has only extremely reduced leaves and are highly dependent on a mycoheterotrophic mode of nutrition (Yukawa 2015, Hayakawa *et al*. 2016, Sakamoto *et al*. 2016). As with some foreign species of *Cephalanthera* (Selosse & Roy 2009), some Japanese species, such as *C. falcata* and *C. subaphylla*, produce achlorophyllous leaf-bearing variants (hereafter albino; Umezawa 2009, Suetsugu & Kato 2014, Suetsugu 2015a, b). None of the Japanese albino *Cephalanthera* variants, however, have been given scientific names. Here, I describe a new form of *C. subaphylla* where the entire plant is achlorophyllous.

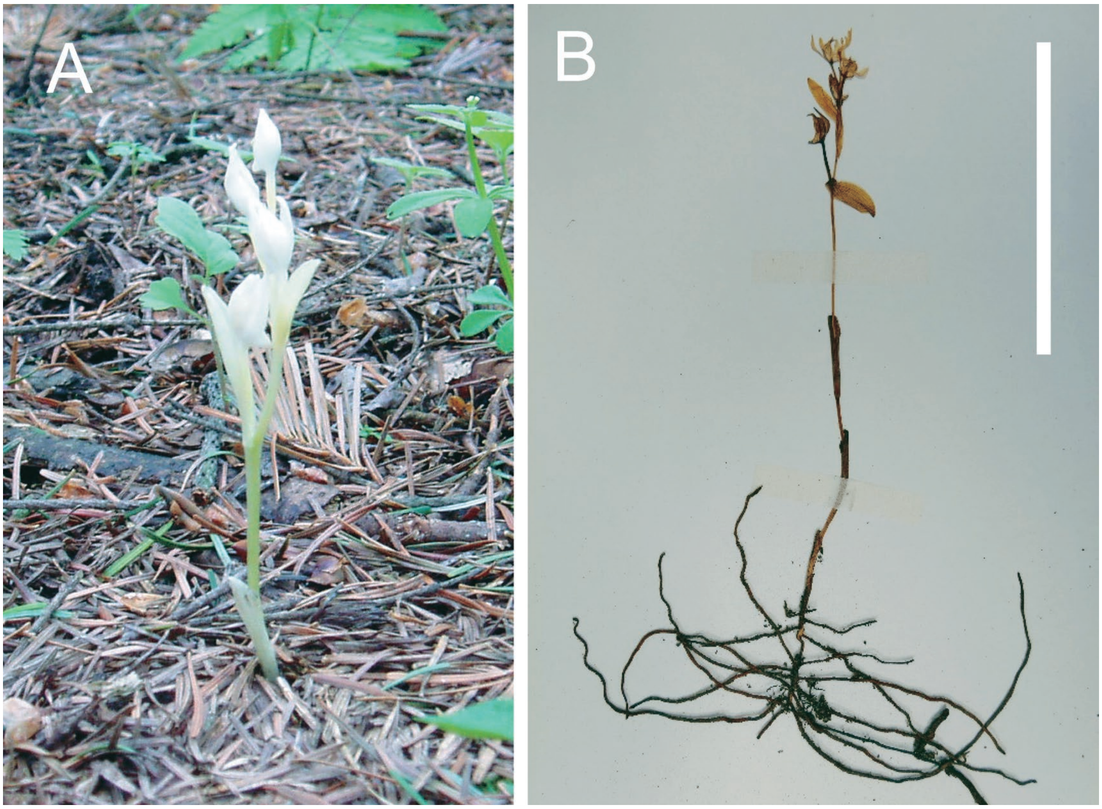

FIG. 1. A. Flowering plant of *Cephalanthera subaphylla* f. *leucophylla* in Sapporo City, Hokkaido. Photographed by Hiroki Onuma, 30 May 2003. B. Holotype of *Cephalanthera subaphylla* f. *leucophylla* (OSA).

Taxonomic treatment

Cephalanthera subaphylla Miyabe & Kudô f. **leucophylla** Suetsugu, **forma nov.** **—**Fig. l.

Cephalanthera subaphylla f. *leucophylla* differs from f. *subaphylla* only in being fully achlorophyllous, but still leaf-bearing (vegetative albino).

Typus. Japan, Shizuoka Pref., Shizuoka City, Aoi-ku, Koyu-gun, 19 May 2016, *Masamichi Matsumoto s. n.* (Holo- OSA).

Japanese name. Usu-ginu-yuushun-ran (Umezawa 2009)

Distribution and notes. *Cephalanthera subaphylla* f. *leucophylla* was discovered in a coniferous plantation dominated by *Chamaecyparis obtusa* Siebold & Zucc. in Shizuoka City, Shizuoka Prefecture, Japan. The type locality contains a mixed population of *C. subaphylla* f. *leucophylla* and *f. subaphylla* with fewer than 10 flowering individuals of each form. Similar albino variants have also been discovered in multiple locations and are called “Usu-ginu-yuushun-ran” in Japanese (Umezawa 2009), although the mutant has not been formally published. For example, albino variants of *C. subaphylla* have been discovered in Sendai City, Miyagi Prefecture, and in Sapporo City, Hokkaido (Umezawa 2009, Sakamoto *et al*. 2016, Onuma, personal communication). These observations indicate that the albino variant has probably evolved independently at multiple locations. Interestingly, while fungal carbon may not fully compensate for loss of photosynthesis and fitness is extremely low in the well-developed leafy *Cephalanthera* albino (Roy *et al*. 2013, Suetsugu & Kato 2014), *C. subaphylla* f. *leucophylla* seemingly shows similar fitness to the green variants in terms of seed production (Suetsugu, unpublished data). Sakamoto *et al*. (2016) showed that the tiny-leaved species, *Cephalanthera subaphylla*, was strongly mycoheterotrophic and obtained most of its carbon from its mycorrhizal fungi. Because *C. subaphylla* has such strong mycoheterotrophic abilities comparable with fully mycoheterotrophic plants, the high dependency on the mycobionts may have lead to the evolution and persistence of albino mutants in *C. subaphylla*.

We thank Mr. Masamichi Matsumoto for the first discovery and report of *Cephalanthera subaphylla* f. leucophylla at the type locality. I also thank Mr. Hiroki Onuma for providing the photograph of *Cephalanthera subaphylla* f. *leucophylla* in its natural habitat in Hokkaido. This work was supported by JSPS KAKENHI Grant Number 15K18470.

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